Citation:

Harper A, James A, Flint A, Astrup A. Increased satiety after intake of a chocolate milk drink compared with a carbonated beverage, but no difference in subsequent ad libitum lunch intake. *Br J Nutr.* 2007 Mar; 97 (3): 579-583.

PubMed ID: 17313721

Study Design:

Randomized crossover design

Class:

A - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To compare the effect on appetite and energy intake of a sugar-sweetened beverage (cola) and a chocolate milk drink, matched for energy content and volume.

Inclusion Criteria:

- Age 20 to 40 years
- Normal weight (BMI range of 18.5 to 25kg/m^2)
- Non-smokers
- Not elite sportsmen
- No previous history of diabetes, overweight, hypertension or liver disease
- No daily use of medicine
- No excessive alcohol use.

Exclusion Criteria:

None reported.

Description of Study Protocol:

Recruitment

Participants were recruited by means of media advertisement.

Design

Randomized crossover design.

Dietary Intake/Dietary Assessment Methodology

- Subjects consumed the meals provided at the research center
- The breakfast had an energy content of 2.5MJ
- Lunch, which was provided separately to each subject and which they could consume *ad libitum* until full, was a pasta salad consisting of a homogeneous mix of pasta, ham, carrots, peas and dressing
- The amount of food ingested at lunch was measured using a digital scale
- Subjects had 20 minutes to eat both breakfast and lunch and the macronutrient composition of the meals was 15% energy from protein, 30% from fat and 55% from carbohydrate (CHO)
- Intake of ad libitum water was allowed with lunch on the first visit and the amount for each subject was recorded; the same amount of water was provided on the second visit
- A drink of 500ml cola or chocolate milk (both 900kJ) was ingested 30 minutes before an *ad libitum* lunch.

Statistical Analysis

- The postprandial response curves were compared by ANOVA using mixed linear models with repeated measures
- Post-hoc ANOVA was used to test differences between the two groups (chocolate milk and cola) at individual time points; the factors were treatment, order and treatment × order
- The mixed procedure in the Statistical Analysis System software package (version 9.1; SAS Institute) was used to test differences in appetite factors and energy intake
- A significance level of $P<0.05$ was used for all statistical tests (two-sided).

Data Collection Summary:

Timing of Measurements

- Subjects were randomly assigned to whether the pre-load on the first visit was cola or chocolate milk (half in each group)
- On each of two test days, with at least one week between them, subjects reported in a fasted state
- Strenuous physical activity was not permitted the day before each visit and it was requested that the evening meal be no later than 7:00 P.M.; water was permitted (up to 300 ml and 200ml on the evening before and the morning of the study, respectively)
- On arrival at 8:00 A.M., subjects were weighed and their height was measured
- Subjects were then provided with breakfast, which consisted of porridge oats with semi-skimmed milk, orange juice and either caffeine-free coffee, tea or water
- An identical breakfast was provided on the second visit
- Visual analogue scales (VAS) were used to record subjective appetite ratings every 30 minutes from 8:30 A.M. (T=0), just before the breakfast meal, until 30 minutes after lunch (T=240 minutes)
- The pre-load beverage of 500ml cola or chocolate milk was given at 11:30 A.M. (T=180 minutes)

- VAS were also recorded just after intake of the beverage (T=190 minutes) and again just before the *ad libitum* lunch (T=210 minutes), which was provided at 12:00 noon.

Dependent Variables

- Ratings of hunger, satiety, fullness, prospective food consumption, thirst, desire for something salty, sweet or fatty, or some meat or fish were recorded on a 100 mm scale anchored with 'not at all' and 'extremely'
- Appearance and palatability of the meals and pre-load beverages was also recorded within 10 minutes of ingestion.

Independent Variables

Consumption of two different pre-lunch beverages: either chocolate milk or soda of 500ml volume and 900 kJ each.

Description of Actual Data Sample:

- *Initial N:* 22 men
- *Attrition (final N):* 22 men
- *Age:* 23±1.8 years
- *Anthropometrics:* BMI = 22.2±1.5kg/m^2
- *Location:* Copenhagen, Denmark.

Summary of Results:

- A drink of 500ml cola or chocolate milk (900kJ) was ingested 30 minutes before an *ad libitum* lunch
- Satiety and fullness were significantly greater (P=0.0007, P=0.0004, respectively) 30 minutes after chocolate milk than after cola
- Ratings of prospective consumption and hunger were significantly greater after cola than after chocolate milk, both immediately after pre-load intake (P=0.008, P=0.01, respectively) and 30 minutes afterwards (P=0.004, P=0.01, respectively)
- There was no significant difference (P=0.42) in *ad libitum* lunch intake after ingestion of chocolate milk (3,145±1,268kJ) compared with cola (3,286±1346kJ).

Visual Analog Scale Ratings	Immediately After Load With Chocolate Milk or Soda	30 Minutes After Load With Chocolate Milk or Soda
Satiety	NS	Chocolate > soda P=0.0007
Fullness	NS	Chocolate > soda P=0.0004

Prospective consumption	P=0.008	Soda > Chocolate P=0.004
Hunger	P=0.01	Soda > Chocolate P=0.01
Amount consumed during *ad libitum* lunch		Soda = Chocolate P=0.42

Other Findings

- There were no differences in subjective evaluation of the two pre-load beverages; both were equally well liked by the subjects
- Overall palatability was not different
- Scores for appearance and taste, etc., of the breakfast and lunch meals did not differ
- The preference for savory or high-protein foods was significantly lower after chocolate milk than after cola at T=210 minutes (data not shown) (salty food: $F(1, 20) = 9.24$, P=0.007; fatty food: $F(1, 20) = 14.79$, P=0.001; meat or fish: $F(1, 20) = 7.96$, P=0.01)
- No significant differences were observed in subjective appetite ratings at other time points of the study (P>0.05)
- No differences in thirst, desire to eat something sweet or well-being were observed throughout the study.

Author Conclusion:

In summary, ingestion of chocolate milk increased subjective ratings of satiety and fullness compared with cola and decreased hunger and prospective consumption, whereas *ad libitum* energy intake was unaltered.

Reviewer Comments:

Well-designed and well-implemented randomized crossover study.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	No
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes

3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	No
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A

3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	N/A
4.1.	Were follow-up methods described and the same for all groups?	N/A
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	N/A
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	N/A
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	Yes
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A

6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	N/A
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	Yes
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	Yes
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	N/A
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes

10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes